

REMARKS

Reconsideration and allowance of the subject application in view of the foregoing amendments and the following remarks is respectfully requested. Entry of this Amendment under Rule 116 is merited as it raises no new issues and requires no further search.

Claims 2-4 and 7-8 are pending in the application. Claims 1, 9-11 have been cancelled without prejudice or disclaimer. Claims 2, 7, and 8 have been rewritten in independent form including all limitations of base claim 1.

The *35 U.S.C. 112, first paragraph* rejection of claim 9 is moot as this claim has been cancelled.

The *35 U.S.C. 103(a)* rejection of claims 1-4, 7, 8, 10 and 11 as being unpatentable over Mathew (4,922,322) in view of Li et al (6,312,830), Kim et al. (6,417,089) and Lin (6,426,556) is noted. The rejection of claims 1, 10 and 11 is mooted as these claims have been cancelled. The rejection of claims 2-4, 7 and 8 has been carefully considered, but is most respectfully traversed.

The present invention is directed to a method of forming a semiconductor device having a bump electrode. The method utilizes a beginning substrate having an aluminum contact pad thereon wherein at least a portion of the aluminum contact pad is exposed through a dielectric layer on the substrate. First, an aluminum layer is formed on the dielectric layer and the exposed portion of the aluminum contact pad. Then, a nickel-vanadium layer is formed on the aluminum layer, and a titanium layer is subsequently formed on the nickel-vanadium layer. After that, a gold bump is selectively formed on the titanium layer at a location corresponding to the aluminum contact pad. Finally, the aluminum layer, the nickel-vanadium layer and the titanium layer are etched with the gold bump being used as a mask.

Applicants respectfully submit that none of the cited references or their combinations teach

or suggest

(1) a step of removing TiO or TiO₂ that may have been formed on the titanium layer before the gold bump is formed (claim 2); and

(2) an etching step utilizing an acidic solution as an etchant to etch the aluminum layer, the nickel-vanadium layer and the titanium layer without significantly affecting the gold bump being used as an etching mask (claims 7 and 8).

Regarding point (1), the Examiner alleged that Lin has taught removing any native/surface oxide being formed on the aluminum pad (page 5 of the final Office Action). Applicants respectfully disagree. It is acknowledged that Lin has taught removing photoresist by an oxide dip which is conducted for 90 seconds in a hydrofluoric acid (Col. 9, lines 50-53). However, after reviewing the descriptions set forth in col. 9, lines 50-53 as well as the entire disclosure of Lin, the applicants cannot locate any teaching or suggestion of *utilizing oxide dip to clean/remove any native/surface oxide being formed on the aluminum pad*, as the Examiner alleged.

Moreover, Lin also fails to disclose, teach or suggest *removing TiO or TiO₂ that may have been formed on the titanium layer before the gold bump is formed*, as presently claimed. Lin teaches that HCl may be optionally used to remove photoresist. In the prior art process, photoresist is removed after the gold bump is formed. See e.g., Figs. 14-15 of Lin or FIGs. 3-4 of Mathew. Thus, a person of ordinary skill in the art would have been motivated to, at best, use HCl to remove photoresist of Mathew and Li, in the manner taught by Lin, after the gold bump has been formed. Such a person of ordinary skill in the art would not have been motivated to use HCl before the gold bump is formed, lacking an adequate suggestion or motivation to do so in the art. In addition, using HCl to remove the photoresist of Mathew and Li before the gold bump is formed would adversely affect the subsequent deposition of gold in forming the gold bump. Accordingly, the teachings of Mathew, Li, and Lin cannot be combined in the manner proposed by the Examiner.

Regarding point (2), it is acknowledged that Kim has taught to etch the UBM layers of Cr or

Cr/Cu using HCl (Col. 6, lines 10-20). However, after reviewing the description set forth in col. 6, lines 10-20 as well as the entire patent of Kim, the applicants cannot locate any teaching or suggestion of *utilizing HCl to etch UBM layers of Al/Ni-V/Cu*, as presently claimed. Accordingly, even if the teachings of Mathew, Li, and Kim were combined as suggested by the Examiner, the resulting method would still fail to teach or suggest every feature of claims 2, 7 and 8.

Withdrawal of the 35 U.S.C. 103(a) rejection of claims 2-4 and 7-8 is believed appropriate and therefore courteously solicited.

For at least the above reasons advanced with respect to claim 2, reconsideration and withdrawal of the 35 U.S.C. 103(a) rejection of claims 3-4 are respectfully requested.

Claim 4 is also patentable over the cited references on its own specific merit since claim 4 recites a step of removing TiO or TiO₂ that may have been formed on the titanium layer by HCl, which is not taught, shown or disclosed in the cited prior art. The Examiner alleged that Kim has taught cleaning/etching UBM layers by HCl (page 6 of the final Office Action). However, after reviewing the descriptions set forth in col. 4, line 65 and col. 6, lines 10-20 as well as the entire patent of Kim, the applicants do not locate any teaching or suggestion of *using HCl to clean/remove TiO or TiO₂ on the titanium layer*, as presently claimed.

Based on the above remarks, claims 2-4 and 7-8 are believed patentable over the cited references. It is therefore respectfully requested that claims 2-4 and 7-8 be allowed so that the entire case may be passed to early issuance.

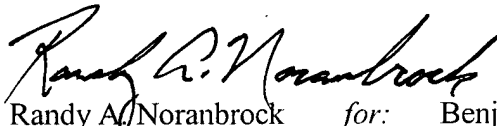
The Examiner is invited to telephone the undersigned, Applicant's attorney of record, to facilitate advancement of the present application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including

extension of time fees, to Deposit Account 07-1337 and please credit any excess fees to such deposit account.

Respectfully submitted,

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